EOS Aura Science Team Meeting
Pasadena Convention Center
28 February – 3 March 2005

Monday, 28 February 2005

Working Group Meeting Schedule

10:00a – 12:00n	Algorithms
9:00a – 12:00n	Education and Public Outreach
1:30p – 4:30p	Data Systems
1:00p – 3:00p	Met Products
3:00p – 5:00p	Aerosols

Tuesday, 1 March 2005

8:30a – 5:00p	Validation Working Group

Wednesday, 2 March 2005

8:30a	Welcome/overview – Mark Schoeberl
8:45a	Comments from NASA Headquarters – Representative TBD
9:00a	TES Update – Reinhard Beer
9:15a	OMI Update – Pieternel Levelt
9:30a	MLS Update – Joe Waters
9:45a	HIRDLS Update – John Gille
10:00a	Break (30 minutes)
10:30a	Data Systems Working Group Report – Lewicki
10:45a	The Atmospheric Chemistry Experiment (ACE): Overview and Initial Validation Results – Walker, Boone, McLeod, and Bernath
11:00a	Ozone Recovery: Indications and Questions – Weatherhead
11:15a	Mid-Latitude and Polar Ozone: Sensitivity to Bromine – Salawitch
11:30a	Solar Occultation Stratospheric Studies: Trends from ATMOS and ACE Spectra and ACE Measurements of Elevated NO_x in February-March 2004 – Rinsland
11:45a	Evidence for the End of the Decline in the Stratospheric Ozone Layer – Yang, Cunnold, Salawitch, and Newchurch
12:00n	Lunch (60 minutes)
1:00p	**Posters**

Wednesday, 2 March 2005 (continued)

3:45p Met Products Working Group Report – Manney

4:00p The OMI NO_2 Product: First Results and Validation Activities – Veefkind
4:15p First OMI Measurements of Volcanic and Anthropogenic SO_2 – Carn
4:30p Aura MLS Sensitivity to Dense Cirrus and Deep Convective Clouds – Wu
4:45p Mixing Ratio of Ozone Inside Deep Convective Clouds – Bhartia
5:00p The Effect of Convection on the Summertime Extratropical Lower Stratosphere as Revealed in Aura and UARS MLS data – Dessler
5:15p Effect of Convection on Clouds and Water in the Tropical Tropopause Layer – Pfister

5:30p Adjourn for the day

Thursday, 3 March 2005

8:30a Validation Working Group Report – Froidevaux and Douglass
9:30a Update on the Aura Validation Experiment (AVE) – Newman
9:45a Summary of the Polar AVE Mission – Schoeberl
10:00a Aura Validation: NOAA Unmanned Air Vehicle Demonstration (NOAA UAV Demo) in Spring 2005 – Elkins

10:15a Break (30 minutes)

10:45a Algorithm Working Group Report – Livesey
10:55a Aerosol Working Group Report – Massie
11:15a Aura Microwave Limb Sounder Observations of the Antarctic Polar Vortex Breakup in 2004 – Manney
11:30a Assimilation of OMI and MLS Ozone Data – Stajner
11:45a Airborne Observations and Satellite Validation: INTEX-A Experience and INTEX-B Plans – Singh
12:00n Identifying Transport Pathways into the Subtropical Lowermost Stratosphere during the Summertime – Pittman

12:15p Lunch (75 minutes)

1:30p Education and Public Outreach Working Group Report – Representative TBD
1:45p Implementation of Cloud Retrievals for Tropospheric Emission Spectrometer (TES) Atmospheric Retrievals – Kulawik
2:00p Cl_x to Cl_y Recovery: New Insights from the SOLVE observations of ClO, ClOOCl, and $ClONO_2$ – Stimpfle
2:15p Intercomparisons with the Harvard *In Situ* Water Vapor Instrument in the Tropics during Pre-AVE and Earlier Aircraft Campaigns: Implications for the Seasonal Cycle of Stratospheric Water Vapor and Aura Validation – Weinstock
2:30p Trapping of Asian Pollution by the Tibetan Anticyclone: A Global CTM Simulation Compared with Aura MLS Observations – Li
2:45p Progress in OMI Measurements of BrO, OClO, and HCHO – Chance
3:00p Top-Down Estimates of VOC Emissions from Space-Based HCHO Column Observations: From GOME to OMI – Jacob

Thursday, 3 March 2005 (continued)

3:15p	Break (30 minutes)
3:45p	Decadal Forecasting of UV Dosage Levels at the Surface: Aura, Airborne, Ground-Based, and Modeling – Anderson
4:00p	*In Situ* Water Vapor Comparisons and Implications for Satellite Validation – Rosenlof
4:15p	Results from the Harvard Isotope Intercomparison Flights – Moyer
4:30p	The First *In Situ* Measurements of Water Isotopes by Laser-Induced Fluorescence Detection on the NASA WB-57 – Hanisco
4:45p	*In Situ* Measurement of Water Vapor Isotopic Composition near the Tropopause: First Results from the Harvard ICOS Isotope Instrument – Keutsch
5:00p	Announcements
5:05p	Adjourn

Poster Presentations

1. **A New Cryogenic Whole Air Sampler for Balloonborne Trace Gas Measurements: Description and Recent Results –** Elliot Atlas, Rich Lueb, Roger Hendershot, Verity Stroud, Sue Schauffler

2. **Characterizations of and Products from OMI UV1 Measurements –** Trevor Beck and Lawrence Flynn

3 **TES Data for Assimilation, Inverse Modeling, and Intercomparison –** Kevin W. Bowman

4. **Infrared Spectrometer Observations during the Polar Aura Validation Experiment (PAVE) –** Michael T. Coffey and James W. Hannigan

5. **Ozone Monitoring Instrument in-flight Calibration Results –** Marcel Dobber

6. **Measurements of Air-Broadened Linewidths for MLS –** Brian J. Drouin

7. **Global Self-Validation of Aura Data –** Timothy J. Dunkerton and <u>Richard K. Scott</u>

8. **Gravity Waves, Ozone, and Polar Stratospheric Clouds: Forecasting, Modeling and MLS/DC-8 Measurements during the Polar AURA Validation Experiment of January-February 2005 –** Steve Eckermann, John McCormack, Dong Wu, Jonathon Jiang, Michelle Santee, Jun Ma, Ag Stephens and Bryan Lawrence

9. **An Exploratory Study to Use OMI Total Ozone Data in Near-Real-Time to Produce a Guidance Product for Air Quality Forecasters –** Jack Fishman, Donna P. McNamara, James J. Szykman, Amy E. Wozniak and John K. Creilson

10. **Preliminary Results from SOWER Water Vapor Match Trials in the Campaign December 2004 to January 2005 –** F. Hasebe, N. Nishi, A. Hamada, M. Shiotani, M. Fujiwara, Y. Inai, H. Voemel, T. Shibata, S. Ogino, T. Thanh, S. Saraspriya, N. Komala, S. Kaloka, S. Hamdi, R. Scheele, P. Fortuin, and S. Oltmans

11. **Cloud Property and Its Implications to Water Vapor Transport Mechanisms over Tibetan and Asian Monsoon Region from "A-Train" Observations –** Yuanlong Hu, Rong Fu, Jonathan Wright, and Jonathan H. Jiang

12. **Stratospheric H_2O Measurements from Aura MLS** – C. Jimenez, H. Pumphrey, and R. S. Harwood

13. **Influence of Isentropic Transport on Seasonal Ozone Variations in the Lower Stratosphere and Subtropical Upper Troposphere –** P. Jing, D. M. Cunnold, E.-S. Yang, and H.-J. Wang

14. **Aura MLS Cloud Measurements: Results from First Six Months in Orbit** – Jonathan H. Jiang, Duane E. Waliser, Dong L. Wu

15. **A Cavity Enhanced Near-Infrared Spectrometer for Airborne Trace-Level Water Isotope (^2H, ^{17}O, and ^{18}O) analysis: DC-8 test flights –** H. J. Jost, Iannone, Romanini, Kerstel

16. **Chemistry/Transport Modeling for the Polar Aura Validation Experiment –** S. R. Kawa, P. A. Newman, M. R. Schoeberl, A. R. Douglass, T. McGee, N. Livesey, L. Froidevaux, J. Waters, ASUR Team

17. **Atmospheric Composition Data and Information Services Center (ACDISC) –** Steve Kempler

18. **Aura Validation Using Statistical Methods That Do Not Require Correlative Measurements to Be Co-Located in Space and Time –** David Lary

19. **Diagnostics for TES Initial Observations –** M. Lampel, H. Worden, R. Beer, K. Bowman, A. Eldering, M. Gunson, M. Luo, G. Osterman, S. Sund Kulawik, J. Worden

20. **TES Science Standard Data Products –** Scott Lewicki

21. **Measurements of Nitrous Oxide from the Aura Microwave Limb Sounder** – N. J. Livesey, G. L. Manney, H. A. Michelsen, M. L. Santee, W. G. Read, J. W. Waters

22. **The UT/LS CO:O_3 Correlation and Implications for Cross-Tropopause Transport from *In Situ* Observations in Several Field Campaigns, Including PreAVE (January 2004) and October AVE (October/November 2004) –** Max Loewenstein, Hansjürg Jost, Jimena Lopez, *et al*.

23. **Comparisons of Preliminary OMI Profile Ozone Products with Those from SBUV/2 –** Craig S. Long, Trevor Beck, Larry Flynn, Shuntai Zhou, Alvin J. Miller

24. **TES Measurement of CO and Preliminary Comparisons to MOPITT, MLS, AVE, and Model Results –** M. Luo, C. Rinsland, S. Sund-Kulawik, A. Goldman, R. Beer, S. Clough, H. Worden, J. Worden, G. Osterman, M. Gunson, D. Rider, S. Sander, M. Lampel, Q. Li

25. **OMI-EOS Research Programme at the Finnish Meteorological Institute: UV, Validation, Very Fast Delivery and Ozone Profiles from Occultation Instruments –** A. Mälkki, G. W. Leppelmeier, J. Tamminen, A. Tanskanen, E. Kyrölä, E. Kyrö, O. Aulamo, and N. A. Krotkov

26. **An NARCM Simulation of Aerosol-Cloud Interaction over Southwest Asia: Initial Results and Comparison with Aura MLS Observations** – R. Munoz-Alpizar, J.H. Jiang, J.P. Blanchet, Qinbin Li

27. **Tropospheric Ozone Lidar and Ozonesondes at RAPCD for Aura Validation** – Mike Newchurch, David Bowdle, John Burris, Bill Irion, Steven Johnson, Mike Gunson, and Rich McPeters

28. **Initial Measurements of Total and Tropospheric Column Ozone by TES** – G. B. Osterman, S. S. Kulawik, J. Worden, A. Eldering, H. M. Worden, K. W. Bowman, M. Luo, D.M. Rider, B. Fisher, M. Lampel, Q. Li, M. R. Gunson, and R. Beer

29. **GEOS-4 Meteorological Analyses and Forecasts in Support of the Aura Mission –** Steven Pawson, Wei-Wu Tan, Gloria L. Manney, J. Eric Nielsen, S. Randolph Kawa

30. **Validating Remote Sensing Measurements of Ice Water Content: Evaluating Flight Plan Requirements Based on *In Situ* and Modeled Data** – David S. Sayres, Jasna V. Pittman, Jessica B. Smith, Elliot M. Weinstock, James G. Anderson, Ann Fridlind, Andrew S. Ackerman, Gerry Heymsfield, and Lihua Li

31. **The Ticosonde-NAME 2004 Program of High-Frequency Radiosonde Measurements over Costa Rica** – H. B. Selkirk, W. Stolz, E. Zarate, P. Manso, J. Amador Astua, W. Fernandez Rojas, J. Valdés Gonzales, J. A. Diaz Diaz, L. Pfister, L. Miloshevich, K. Heinrich Bettoni

32. ***In Situ* Measurements of Ice Water Content on the NASA WB-57F during MidCiX: Implications for MLS and CloudSat Validation** – J. Ryan Spackman, David S. Sayres, Jasna V. Pittman, Jessica B. Smith, Elliot M. Weinstock, James G. Anderson, Cynthia H. Twohy, Gregory Kok

33. **SHADOZ (Southern Hemisphere Additional Ozonesondes) Accomplishments, Status, and Strategies in the Aura Period** – Anne M. Thompson, Jacquelyn C. Witte, Samuel J. Oltmans, and the SHADOZ Team

34. **First Results from the OMI Cloud Pressure Algorithm Based on UV Measurements** – Alexander P. Vasilkov and Joanna Joiner

35. **Total Ozone from OMI Using the DOAS Method: First Results and Preliminary Validation** – J. P. Veefkind, J. F. de Haan, E. J. Brinksma, M. Kroon, P. K. Bhartia, K. Yang, and P. F. Levelt

36. **CO_2, CH_4, and CO Column Abundances Retrieved from Ground-Based Near-Infrared Solar Spectra** – Rebecca Washenfelder

37. **Resonance Fluorescence Instrument for the *In Situ* Detection of BrO in the Atmosphere** – David M. Wilmouth, Richard M. Stimpfle, and James G. Anderson

38. **Validation of Aerosol Products with Accurate *In Situ* Aerosol Measurements: SAGE II, SAGE III and POAM II** – James C. Wilson and J. Michael Reeves

39. **Radiometric and Frequency Calibration for EOS-Aura TES Infrared Spectra** – Helen M. Worden, Reinhard Beer, Kevin W. Bowman, Brendan Fisher, Mingzhao Luo, Gregory Osterman, David Rider, Edwin Sarkissian, and Denis Tremblay

40. **Change in Ozone Trends at Southern High Latitudes** – Eun-Su Yang, D. M. Cunnold, M. J. Newchurch, and Ross J. Salawitch

41. **TES Ozone Retrievals, Error Covariances, and Vertical Resolution** – John Worden

Abstracts for Oral Presentations

Decadal Forecasting of UV Dosage Levels at the Surface: Aura, Airborne, Ground-Based, and Modeling (James G. Anderson)

An important objective of the Aura collaborative science effort is the development of a strategy linking satellite and airborne observations with a modeling approach that forecasts secular trends in UV surface dosage, particularly over populated regions, and then tests those results against ground-based observations of UV. The credibility of this approach will depend upon the development of and understanding of the balance between chemical control of the column ozone concentration vs. dynamical control; establishment of the mechanism for strat/trop exchange in the TTL; seasonal patterns in meridional exchange between the tropics, subtropics, midlatitudes, and polar regions in the lower stratosphere; and the role of tropospheric chemistry in the control of photochemical oxidants and aerosol optical depth in the face of rapidly increasing nitrate, sulfate, organic and heavy metal emission from developing economies across the globe.

Mixing Ratio of Ozone Inside Deep Convective Clouds (P. K. Bhartia, Jerry Ziemke, Sushil Chandra, Joanna Joiner, Alexander Vassilkov)

Deep convective clouds (DCC) are believed to be the main mechanism by which pollutants (as well as clean air) from the planetary boundary layer are transported into the upper troposphere. However, modeling and measurement of trace gas concentrations inside these clouds is difficult. We present the first results of a novel technique to estimate O_3 mixing ratio inside DCCs using OMI data. The technique relies on the fact that the radiation measured by solar backscatter instruments, such as OMI, comes from deep within a cloud rather than from its surface. OMI is particularly suitable for such measurements for its field-of-view is just about the right size to observe these clouds, and it can provide all the necessary information to estimate the O_3 mixing ratio inside DCCs. The method we describe can be applied to measure the mixing ratio of other trace gases in such clouds, including NO_2, CO and CO_2, using suitably designed instruments; they are particularly suitable for satellites in mid to high altitude orbits (>20,000 km) that can track such clouds and make such measurements continuously

First OMI Measurements of Volcanic and Anthropogenic SO_2 (Simon A. Carn, Nick Krotkov, Arlin J. Krueger, Kai Yang)

The Ozone Monitoring Instrument (OMI) on EOS Aura offers unprecedented spatial and spectral resolution and global coverage for space-based UV measurements of SO_2. Implementation of the planned Maximum Likelihood (ML) SO_2 algorithm ($OMSO_2$), which relies on spectral fitting, has been delayed until in-flight calibration of OMI is complete. In lieu of $OMSO_2$, we have developed a fast retrieval algorithm that produces SO_2 column amounts using residuals from the operational ozone code ($OMTO_3$) at 4 wavelengths corresponding to maxima and minima in the SO_2 absorption cross-section (Band Residual Difference [BRD] algorithm).

The BRD algorithm is providing unique observations of SO_2 in volcanic and polluted regions. Noise levels are higher than can potentially be achieved using the ML method, but still five times better than EP TOMS, allowing robust detection of lower tropospheric SO_2. Using the BRD technique we are measuring passive degassing from several volcanoes on a daily basis. Explosive volcanic eruption clouds can be tracked for longer than was possible with TOMS, providing critical data for aviation hazard mitigation. Anthropogenic SO_2 has been detected over eastern China, South America and Europe.

Using OMI data, we can now directly compare global SO_2 emissions from anthropogenic and volcanic sources for the first time, and thus provide important new constraints on the relative magnitude of these fluxes. Such measurements are essential given the growing concern over the response of the Earth to anthropogenically-forced climate change and intercontinental transport of air pollution. The fast BRD SO_2 retrieval is also amenable to operational SO_2 alarm development, and near real-time application for aviation hazards and volcanic eruption warnings.

Progress in OMI Measurements of BrO, OClO, and HCHO (Kelly Chance and Thomas P. Kurosu)

We report progress in determining abundances of the trace gases BrO, OClO, and HCHO from the EOS-Aura Ozone Monitoring Instrument. Updates and improvements in the data analysis algorithm are described and examples of measurements given. OMI BrO includes releases from the shelf ice in 2004 Antarctic spring. HCHO includes production from biogenic sources, biomass burning, and possibly from agriculture and urban pollution. We will examine Asian HCHO production changes before and after the December 26, 2004 tsunami. OClO from Arctic spring 2005 will be presented if measurable enhancements have occurred in time to analyze and present at this meeting.

The Effect of Convection on the Summertime Extratropical Lower Stratosphere as Revealed in Aura and UARS MLS Data (A. E. Dessler and W. G. Read)

Aura MLS observations of H_2O and clouds near the base of the overworld (~380-K potential temperature) are examined in summertime northern mid-latitudes, with a focus on how the H_2O abundance here is influenced by deep convection. We show that summertime mid-latitude convection has a significant effect on the water vapor budget here, despite relatively infrequent convective penetration to these altitudes.

Aura Validation: NOAA Unmanned Air Vehicle Demonstration (NOAA UAV Demo) in Spring 2005 (James W. Elkins, Samuel J. Oltmans, and David W. Fahey)

NOAA and NASA Dryden have teamed together to perform one of the first atmospheric science demonstrations using the NASA Altair UAV (high-altitude version of the Predator UAV) during the spring of 2005. Both agencies are attempting to make UAVs part of their operations in the near future. The Altair UAV is capable of a maximum of 36-hour flight duration, speed of ~120-150 kts, payload of ~200 kg, and maximum altitude of 15 km. The purpose of the NOAA UAV Demo is test atmospheric research instruments and NOAA operational requirements (mapping, fisheries management, and marine sanctuary enforcement) on a UAV. NOAA/CMDL has reconfigured an instrumental package that includes a two-channel gas chromatograph (ACATS-II class) and a modified commercial ozone photometer into a small package weighing ~20 kg. The UAV Chromatograph for Atmospheric Trace Species (UCATS) will measure nitrous oxide (N_2O), sulfur hexafluoride (SF6), chlorofluorocarbon-11 (CFC-11, CCl3F), CFC-12 (CCl2F2), and halon-1211 (CBrClF2) every 70 seconds. Ozone (O_3) will be measured once every 10 seconds. Ocean color measurements (chlorophyll) near the coastlines and water vapor measurements by microwave radiometers for atmospheric rivers observations (tropical tropospheric air mass movement into mid latitudes) are planned. The payload also includes a Digital Camera System and real-time infrared and visible surveying by a sky ball for photographic retrieval. David Fahey of the NOAA/AL will be a Co-Mission Scientist and NOAA/AL scientists will be involved in flight planning. This presentation will cover the specifics of the NOAA UAV demo, and possible flights along the Aura ground track that will help validate Aura measurements of N_2O, CFC-11, CFC-12, and O_3 over the Pacific Ocean.

The First *In Situ* Measurements of Water Isotopes by Laser-Induced Fluorescence Detection on the NASA WB-57 (Thomas F. Hanisco, Jason St. Clair, and James G. Anderson)

We will discuss the design and performance of the Harvard HO_x isotopes instrument (HOxotope) that uses a combination of photolysis and laser induced fluorescence to detect HDO and H_2O on the NASA WB-57. It is expected that these measurements of water isotopes will play a central role in AURA collaborative science and satellite validation experiments, placing an increased need for validation of the in situ observations themselves. The fast fluorescence technique addresses this need as a complement diode laser absorption techniques used by other in situ water isotope instruments and by providing an independent measurement to help identify artifacts and contribute to the validation process. Data from validation test flights during January 2005 that demonstrate the fast sampling time constants and high sensitivity of the HOxotope fluorescence technique will be presented. These in situ measurements show the utility of the HO_x isotopes technique for both validation of in situ water isotope measurements and direct participation in AURA collaborative science.

Top-Down Estimates of VOC Emissions from Space-Based HCHO Column Observations: From GOME to OMI (Daniel J. Jacob, Paul I. Palmer, Dorian S. Abbot, Tzung-May Fu, Dylan B. Millet, and Solene Turquety, Kelly Chance. Thomas Kurosu, Jenny Stanton, Michael J. Pilling Alex Guenther, Christine Wiedinmyer, Alan Fried, Shelley N. Pressley and Brian Lamb)

The OMI instrument aboard Aura measures HCHO columns by solar backscatter in the 340 nm HCHO absorption band [Chance et al., this meeting]. These HCHO column measurements provide top-down constraints on reactive VOC emissions that can be used to test and complement bottom-up emission inventories. We will present our latest work in exploiting these constraints using the long-term (1995-present) HCHO column record from the GOME instrument aboard ERS-2. Topics will include (1) generation of a high-quality data set of GOME HCHO columns from 1995 to present; (2) Testing of model-derived relationships between HCHO columns and VOC emissions using kinetic information, surface measurements, and data from the ICARTT aircraft campaign; (3) comparison of GOME-derived VOC emissions for North America with isoprene flux measurements and a state-of-the-science biogenic VOC emission inventory; (4) evaluation of inventories for biogenic and anthropogenic VOC emissions in East Asia. We will discuss the extension of these analyses to OMI.

***In Situ* Measurement of Water Vapor Isotopic Composition near the Tropopause: First Results from the Harvard ICOS Isotope Instrument** (Frank N. Keutsch, Elisabeth J. Moyer, David S. Sayres, Norton T. Allen, and James G. Anderson)

Because water isotopic composition is altered by all processes involving condensation or evaporation, it can serve as a tracer of the processes governing the water content of air ascending to the stratosphere—a science goal of the Aura mission. We will discuss the design of the Harvard ICOS Isotope Instrument, a new in-situ instrument, which offers significant improvement in sensitivity over traditional in-situ mid-infrared spectroscopic instruments. We report on the first flights of this instrument and measurements of HDO, $H_2{}^{18}O$, and H_2O in the near-tropopause region that demonstrate an integration time and sensitivity that allow resolving the small spatial scales of tropical deep convection plumes and cirrus layers. The measurements also demonstrate that the HDO/H_2O isotopic ratio provides a unique tracer, different from e.g., water vapor or CH_4, which should prove valuable for evaluating models of stratosphere-troposphere exchange.

Implementation of Cloud Retrievals for Tropospheric Emission Spectrometer (TES) Atmospheric Retrievals (Susan Sund Kulawik, John Worden, Annmarie Eldering, Kevin Bowman, Helen Worden, Greg Osterman, Ming Luo, Michael Lampel, David Rider, Brendan Fisher, Michael Gunson, Reinhard Beer)

Clouds substantially affect the observed infrared radiance and are ubiquitous in the atmosphere. Retrieval of temperature and trace gases must account for how clouds of all optical depths affect the observed radiation field. We have implemented an algorithm for the Tropospheric Emission Spectrometer (TES) to retrieve the altitude and effective optical depth of a frequency-dependent single-layer cloud. Comparing simulated radiances with this approach to a multiple scattering model show that this approach succeeds for targets containing a wide range of cloud optical depths and altitudes. The cloud retrieval approach makes possible the retrieval and error characterization of atmospheric parameters like temperature, water, and ozone, in the presence of clouds. TES retrievals with actual observed radiances are shown.

Trapping of Asian Pollution by the Tibetan Anticyclone: A Global CTM Simulation Compared with Aura MLS Observations (Qinbin Li, Jonathan H. Jiang, Dong L. Wu, William G. Read, Nathaniel J. Livesey, Joe W. Waters Yongsheng Zhang, Bin Wang Mark J. Filipiak, Cory P. Davis Solene Turquety, Shiliang Wu, Rokjin J. Park, Robert M. Yantosca, Daniel J. Jacob)

The GEOS-CHEM global 3-D CTM driven by assimilated meteorological data is used to analyze observations of CO and upper tropospheric clouds from the Microwave Limb Sounder (MLS) aboard the NASA Aura satellite. Aura MLS observations during 25 August-6 September 2004 reveal elevated CO concentrations and dense high-altitude clouds in the upper troposphere over the Tibetan Plateau and southwest China, collocating with the upper-level Tibetan anticyclone. Similar enhancements in CO are also seen in MOPITT observations during the same period. GEOS-CHEM simulations indicate the transport of boundary layer pollution by Asian summer monsoon (ASM) convection and orographic lifting to the upper troposphere over South Asia, where the simulated distributions of CO closely resemble the satellite observations. In addition, model results show elevated aerosols and ozone in the anticyclone region. Analysis of simulated CO and aerosols indicate that the upper-level Tibetan anticyclone effectively 'traps' anthropogenic emissions from northeast India and southwest China lifted to the upper troposphere. These aerosols may be responsible for the formation of some of the dense high-altitude clouds observed by MLS.

Aura Microwave Limb Sounder Observations of the Antarctic Polar Vortex Breakup in 2004 (Gloria L. Manney, Michelle L. Santee, Nathaniel J. Livesey,Lucien Froidevaux, Hugh C. Pumphrey, William G. Read, and Joe W. Waters)

The Microwave Limb Sounder (MLS) onboard the Earth Observing System Aura satellite has greatly expanded capabilities over its predecessor on the Upper Atmosphere Research Satellite. Continuous coverage of the polar regions and measurements of additional species are enhancing studies of polar vortex evolution; examination of the MLS constituents in conjunction with meteorological fields facilitates analysis of transport processes. We use Aura MLS data from September through December 2004, in conjunction with meteorological analyses from the Goddard Earth Observing System, Version 4 (GEOS-4) at NASA's Global Modeling and Assimilation Office, to detail the observed breakup of the Antarctic polar vortex. We focus primarily on the middle and lower stratosphere, including the breakup of the ozone hole and dispersal of chemically-processed air. MLS HCl observations in the period after chlorine deactivation provide a particularly vivid view of the evolution and structure of the decaying vortex in the lower stratosphere.

Results from the Harvard Isotope Intercomparison Flights (Elisabeth J. Moyer, Thomas F. Hanisco, Frank N. Keutsch, David S. Sayres, Jason M. St. Clair, Norton T. Allen, J. Ryan Spackman, Robin A. Lockwood, Elliot M. Weinstock, James G. Anderson)

We report on results from a series of test flights of two new instruments designed for in-situ measurements of the isotopic composition of water vapor in the near-tropopause region (the Harvard ICOS Isotope Instrument and the Harvard HOxotope Instrument). The instruments were flown on NASA’s WB-57 aircraft in Dec and Jan 2004/2005 and each measured H_2O and HDO; the ICOS instrument also measured $H_2{}^{18}O$, $H_2{}^{17}O$, and CH_4. For the purposes of validation, the payload also included two well-established instruments measuring water vapor and total water. The multi-instrument flight series was intended to allow unquestionable diagnosis of any instrument issues and confirmation of instrument performance. We show comparisons of water measurements from all four instruments, demonstrating the sensitivity, time response, and dynamic range of the new instruments. The performance of the new water isotope instruments in flight met design specifications and allows observation of small changes in isotopic composition in cirrus layers near the tropopause. We show observed isotopic features associated both with cirrus and with cloud-free airmasses of different origin, and discuss how these features can allow diagnosis of the processes bringing water to the near-tropopause region.

Update on the Aura Validation Experiment (AVE) (Paul Newman, David Fahey, Mark Schoeberl, Eric Jensen)

The Aura Validation Experiment (AVE) was formulated to provide co-located aircraft observations for the Aura satellite instruments. The first AVE experiment (Pre-AVE) was staged in January 2004 to test the WB-57F configuration, shake out bugs in the in-situ instruments, and to investigate the TTL. The second AVE experiment (AVE-October) was flown in October 2005 from Houston with a mixed WB-57F payload of in-situ and remote sensing instruments. The third AVE experiment (PAVE) was flown in January 2005 from Pease, New Hampshire with a mixed DC-8 payload of in-situ and remote sensing instruments. In this overview talk, some highlights of those missions will be given, and a presentation on future AVE missions will be discussed.

Effect of Convection on Clouds and Water in the Tropical Tropopause Layer
(Leonhard Pfister and Eric Jensen)

Water and clouds in the tropical tropopause layer (TTL) are important because: (1) its positive radiative balance allows it to control water vapor input into the lower stratosphere; and (2) cloud formation has a significant impact on the global radiative balance due to the cold temperatures. The bottom of the tropical tropopause layer is also above the altitude of most tropical convective detrainment. However, enough detrainment occurs within the TTL to make convective turnover times comparable to transit times via radiatively induced ascent. We thus can expect a fairly complex interaction between hydration/dehydration associated with convection, and dehydration due to horizontal flushing through cold regions. Still, comprehensive microphysical/dynamical models have been able to reproduce TTL water vapor and clouds well without any convective injection at all. The caveat to this is that the TTL cloud and water vapor measurements with the kind of vertical resolution needed to really constrain the models has been limited to long term climatologies from solar occultation methods. New measurements from the Aura and Calypso satellites will solve this problem (Aura MLS, HRDLS, and TES for water, and Aura MLS, HRDLS, and Calypso for clouds). The ultimate goal of this work is to understand the relative importance of convective processes and in-situ dehydration in the TTL, and to both test and further develop that understanding with satellite measurements.

This paper presents results that include convective injection in a trajectory curtain based complete microphysical model. Microphysical calculations for 648 trajectory curtains are completed with convective injection along each trajectory. The altitude of convective injection along the trajectory is derived from a comparison of temperature profiles from meteorological analyses and brightness temperatures from 3-hourly geostationary meteorological satellite data. A 7K offset is included in the geostationary satellite imagery to reflect the underestimation of cloud top altitudes from thermal imagery. This yields convective turnover times that are at least comparable to previous studies using thermal imagery and trace constituent analyses. The major results so far are: (1) significant hydration (50 to 100%) in the lower part of the TTL, with perhaps 10% hydration at levels above 365K; (2) significant reduction (30-40%) in convective effects due to subsequent dehydration from horizontal flushing through cold regions; and (3) uniform distribution of hydration across the tropics. Further calculations will: (1) refine the altitudes of convective injection; (2) examine the sensitivity to particle size distributions; and (3) examine different years and seasons with a particular emphasis on years where Aura observations will be available.

Identifying Transport Pathways into the Subtropical Lowermost Stratosphere during the Summertime (Jasna V. Pittman, Elliot M. Weinstock, David S. Sayres, Jessica B. Smith, James G. Anderson, Owen R. Cooper, Steven C. Wofsy, Irene Xueref, Christoph Gerbig, Bruce C. Daube, Erik C. Richard, Brian A. Ridley, Andrew Weinheimer, Max Loewenstein, Hans-Jürg Jost, Jimena P. Lopez, Michael J. Mahoney, Thomas L. Thompson)

We use *in situ* measurements of water vapor (H_2O), ozone (O_3), carbon dioxide (CO_2), nitric oxide (NO), total reactive nitrogen (NO_y), and carbon monoxide (CO) to study summertime dynamics in the subtropical lowermost stratosphere. These measurements were obtained during the Cirrus Regional Study of Tropical Anvils and Cirrus Layers - Florida Area Cirrus Experiment (CRYSTAL-FACE) campaign in July 2002 aboard NASA's WB-57 aircraft. In this study, we analyze tracer-tracer correlations, we apply the Empirical Orthogonal Function (EOF) method on tracer fields, and we calculate 3-D backward trajectories in order to identify source regions of air and the corresponding transport pathways that bring air into the subtropical lowermost stratosphere over Florida.

The high spatial and temporal resolution that in situ measurements provide allow us to track changes in the chemical composition of this region throughout the month. Tracer-tracer correlation plots in clear air and EOF analysis show evidence of three major source regions of air, namely high-latitude stratospheric air, tropical air from the upper troposphere and lower stratosphere, and convective air. The presence of air masses from each of these source regions implies that equatorward transport, poleward transport, and convective transport, respectively, brought air to the lowermost stratosphere over Florida.

Our analysis shows that the convective transport was not episodic, but rather persistent throughout the month. The results from tracer analysis are consistent with the results obtained from 3-D backward trajectories both in the geographical origin of the air sampled over Florida and the timing of the dominant transport pathway. The equatorward transport has been associated with monsoon circulation. In this work we present evidence of the effect of this circulation on the chemical composition of the lowermost stratosphere over North America using O_3-H_2O correlations from the CRYSTAL-FACE and the Stratospheric Tracers of Atmospheric Transport (STRAT) campaigns during the summer. These results provide new insights into the spatial and temporal resolution of the dynamics of the subtropical lowermost stratosphere during the summertime. Understanding the dynamics of this region of the atmosphere is crucial for predicting long-term changes in O_3 and H_2O in the stratosphere and their resulting radiative and chemical impacts.

Solar Occultation Stratospheric Studies: Trends from ATMOS and ACE Spectra and ACE Measurements of Elevated NO_x in February-March 2004 (Curtis P. Rinsland, Chris Boone, Ray Nassar, Kaley Walker, Peter Bernath, John C. McConnell)

Atmospheric Chemistry Experiment (ACE) measurements of NO_x (NO+NO_2) in the Arctic during February and March 2004 show the highest levels observed in that region. Mixing ratios of NO exceeded 1.3 ppmv (1 ppmv=10-6 by volume). The elevated NO_xlevels in the upper stratosphere coincided with vortex locations and likely resulted from particles emitted by intense solar flares that occurred the previous October and November possibly with enhancements from auroral activity followed by downward transport where the elevated levels persisted due to the long lifetime of NO_x during darkness. Gradual NO_x reductions due to descent and dilution in vortex airmasses are observed and quantified.

Lower stratospheric trends have been derived from comparison of ACE and ATMOS (Atmospheric Trace MOlecule Spectroscopy) measurements near 30˚N latitude from measurements in 1985, 1994, and 2004. Mixing ratios are referenced to those for N_2O to account for the dynamic history of the observed airmasses. Trends are reported for HF, HCl, CCl_3F_2, CCl_3F, CHF_2Cl, and SF_6 and compared with reported measurements and model predictions. Results include evidence that HCl has reached its maximum and begun a low decrease.

***In Situ* Water Vapor Comparisons and Implications for Satellite Validation**
(Karen Rosenlof)

At the conclusion of the AVE campaign in Oct/Nov 2004, a balloon/aircraft intercomparison designed to examine water vapor measurements was carried out. Significant differences were found between measurements from different instruments. Similar differences have been found in past measurement intercomparisons. A summary of the recent comparison and past comparisons involving the CMDL frostpoint balloon will be presented. How these differences may impact both satellite validation of stratospheric water vapor and interpretation of water vapor data sets will be discussed.

Mid-Latitude and Polar Ozone: Sensitivity to Bromine (R. J. Salawitch, D. K. Weisenstein, L. J. Kovalenko, T. Canty, C. E. Sioris, P. O. Wennberg, K. Chance, M. K. W. Ko, C. A. McLinden)

We will examine the sensitivity of mid-latitude ozone trends and polar ozone loss to levels of stratospheric bromine. This work is motivated by numerous measurements of BrO that suggest inorganic bromine near the tropopause is 4 to 8 ppt greater than assumed in most models. This additional bromine is likely carried to the stratosphere by short-lived biogenic compounds and their decomposition products. Including this additional bromine in an ozone trend simulation increases the computed ozone depletion over the past ~25 years, leading to better agreement between measured and modeled ozone trends. Also, allowing for excess bromine leads to better agreement between measured and modeled chemical loss of Arctic ozone for the SOLVE winter (1999-2000). Measurements of BrO, ClO, and O_3 by the MLS instrument on Aura, together with well-designed aircraft observations in the tropics and polar regions, are important for reducing uncertainties in the quantification of both mid-latitude ozone trends and polar ozone loss.

Summary of the Polar AVE Mission (Mark Schoeberl and Eric Jensen)

The Polar Aura Validation Mission took place from Jan 25, 2005 to Feb. 9, 2005 out of Portsmouth, NH. The mission consisted of 10 instruments loaded on the NASA DC-8. The instrument payload included in situ chemical measurements of H_2O, O_3, CO, N_2O, HNO_3, and NO_2. There were two ozone lidar measurements, aerosol lidar measurements and temperature lidar measurements. The German ASUR instrument provided emote microwave measurements of ClO, HCl, HNO_3 and N_2O were provided by, while the NCAR FTIR provided IR spectra using solar occultation. The mission included the DIAL up/down-looking ozone/aerosol lidar and the AROTAL uplooking ozone/temperature lidar. The polar vortex cooperated with us by extending southward over Hudson Bay during most of the mission period. We made several flights into the vortex and at mid-latitudes along the Aura measurement track and the lidars observed extensive ozone loss, PSCs. The remote microwave measurements observed high values of ClO and HCl loss. Vertical profiling flights for OMI were made off the coast and in the continental regions.

Airborne Observations and Satellite Validation: INTEX-A Experience and INTEX-B Plans (Hanwant B. Singh, William H. Brune, James H. Crawford, and Daniel J. Jacob)

Intercontinental Chemical Transport Experiment (INTEX; http://cloud1.arc.nasa.gov) is an ongoing two-phase integrated atmospheric field experiment being performed over North America (NA). Its first phase (INTEX-A) was performed in the summer of 2004 and the second phase (INTEX-B) is planned for the early spring of 2006. The main goal of INTEX-NA is to understand the transport and transformation of gases and aerosols on transcontinental/intercontinental scales and to assess their impact on air quality and climate. Central to achieving this goal is the need to relate space-based observations with those from airborne and surface platforms.

During INTEX-A, NASA's DC-8 was joined by some dozen other aircraft from a large number of European and North American partners to focus on the outflow of pollution from NA to the Atlantic. Several instances of Asian pollution over NA were also encountered. INTEX-A flight planning extensively relied on satellite observations and in turn Satellite validation (Terra, Aqua, and Envisat) was given high priority. Over 20 validation profiles were successfully carried out. DC-8 sampling of smoke from Alaskan fires and formaldehyde over forested regions, and simultaneous satellite observations of these provided excellent opportunities for the interplay of these platforms.

The planning for INTEX-B is currently underway, and a vast majority of "standard" and "research" products to be retrieved from Aura instruments will be measured during INTEX-B throughout the troposphere. INTEX-B will focus on the inflow of pollution from Asia to North America and validation of satellite observations with emphasis on Aura. Several national and international partners are expected to coordinate activities with INTEX-B, and we expect its scope to expand in the coming months. An important new development involves partnership with an NSF-sponsored campaign called MIRAGE (Megacity Impacts on Regional and Global Environments-Mexico City Pollution Outflow Field Campaign; http://mirage-mex.acd.ucar.edu/index.html). This partnership will utilize both the NASA-DC-8 and NCAR C-130 aircrafts and greatly expand the temporal and spatial coverage of these experiments. We will briefly describe our INTEX-A experience and discuss plans for INTEX-B activities especially as they relate to validation and interpretation of Aura observations.

Assimilation of OMI and MLS Ozone Data (I. Stajner, K. Wargan, L.-P. Chang, H. Hayashi, S. Pawson, L. Froidevaux, and N. Livesey)

Ozone data retrieved from the Aura OMI and MLS instruments have been assimilated into the ozone model at NASA's Global Modeling and Assimilation Office (GMAO). This assimilation produces ozone fields that are superior to those from the operational product that assimilates Solar Backscatter Ultraviolet (SBUV/2) retrievals. Use of ten days of OMI data and five days of

MLS data yielded a better representation of the "ozone hole", sharper ozone gradients in the lower stratosphere, and an improved agreement with independent ozone sonde data.

Inclusion of OMI and MLS data together, or separately, in the assimilation system provides a way of checking how consistent OMI and MLS data are with each other, and with the ozone model. Differences between OMI and forecast total ozone columns decrease when MLS data are assimilated. This indicates that MLS stratospheric ozone profiles are consistent with OMI total ozone columns. The evaluation of error characteristics of OMI and MLS ozone will continue as data from newer versions of retrievals become available.

The goal is to produce global assimilated ozone fields that combine measurements from different Aura instruments, an ozone model, and their respective error characteristics. We plan to use assimilated ozone fields to estimate tropospheric ozone. We also plan to investigate impacts of assimilated ozone fields on numerical weather prediction through their use in radiation models and in constraining the assimilation of infrared nadir radiance data from NASA's Advanced Infrared Sounder (AIRS). If preliminary results are available for either of these topics, they will be shown.

Cl_x to Cl_y Recovery: New Insights from the SOLVE observations of ClO, ClOOCl, and $ClONO_2$ (Richard M. Stimpfle, David M. Wilmouth, and James G. Anderson)

There is surprisingly little quantitative understanding, based upon in-situ observations, concerning how the winter-time polar vortex recovers from high levels of chlorine activation, $Cl_x/Cl_y \sim 1$, back to normal levels, $Cl_x/Cl_y \sim 0.03$. The simultaneous SOLVE observations of ClO_x (ClO and ClOOCl) and $ClONO_2$ offer some new insights that contradict the generally accepted notion, based upon the Cl_y budget and HCl observations in the absence of $ClONO_2$ observations, that recovery takes place primarily into $ClONO_2$ before the net production of appreciable levels of HCl (see for example, WMO Report 27, Scientific Assessment of Ozone Depletion: 1994, page 3.4).

The net production of $ClONO_2$ is driven largely by the reintroduction of NO_x from HNO_3 photolysis and by HNO_3 reaction with OH. The net production of HCl is driven largely by the reactions of $Cl + CH_4$ and $ClO + OH$. Depending on the mixing ratios of O_3 and HNO_3, the competition between $ClONO_2$ and HCl recovery can be nearly equal. If other HCl production channels are present, such as ClO + HO2, predicted HCl production would increase. In any case, both HCl and $ClONO_2$ production require the presence of sunlight. There is no induction period where $ClONO_2$ production occurs while HCl production does not. The presence or reappearance of PSC-like heterogeneous reactions will of course reactivate chlorine. The SOLVE HCl observations from ALIAS are inconsistent with this interpretation of chlorine photochemistry.

The Atmospheric Chemistry Experiment (ACE): Overview and Initial Validation Results
(Kaley A. Walker, Chris Boone, Sean D. McLeod, and Peter F. Bernath)

The Atmospheric Chemistry Experiment (ACE), also known as SCISAT-1, is a

Canadian scientific satellite mission designed to make remote sensing measurements of the Earth's atmosphere. It was launched on August 12, 2003 into a 650-km altitude, 74˚ circular orbit. The primary instrument on-board SCISAT-1 is a high-resolution (0.02 cm-1) Fourier

Transform Spectrometer (ACE-FTS) operating between 750 and 4500 cm^{-1}. It also contains two filtered imagers to measure atmospheric extinction due to clouds and aerosols at 0.525 and 1.02 microns. The secondary instrument is a dual UV-visible-NIR spectrograph called MAESTRO

(Measurements of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation) which extends the wavelength coverage to the 280-1030 nm spectral region. Both instruments use the solar occultation technique to obtain profiles of atmospheric trace gas species, temperature and pressure. The goals of the ACE mission are: (1) to measure and to understand the chemical and dynamical processes that control the distribution of ozone in the upper troposphere and stratosphere, with a particular emphasis on the Arctic region; (2) to explore the relationship between atmospheric chemistry and climate change; (3) to study the effects of biomass burning in the free troposphere; (4) to measure aerosol number density, size distribution and composition in order to reduce the uncertainties in their effects on the global energy balance. The mission status and initial validation comparison results will be presented in this talk.

The OMI NO_2 Product: First Results and Validation Activities (J. P. Veefkind, J. Gleason, E. Celarier, E. Bucsela, E. J. Brinksma, D. Swart, A. J. C. Berkhout, P. F. Levelt)

The OMI instrument on the EOS-Aura satellite makes it possible to derive NO_2 concentrations on urban, regional and global scales on a daily basis. Because the NO_2 concentration provides information on air quality, there is a large interest in the OMI data from scientists, governments as well as the general public. However, before making the OMI NO_2 data publicly available, the data should be of good quality and have been validated using correlative observations. For NO_2 this is a challenging task, because there are few correlative data sets available. Also, the retrieval of tropospheric NO_2 depends, amongst others, on estimates of the profile shape of NO_2 in the lower troposphere. Routine observations of NO_2 profiles are even more sparse than total column measurements. For this reason, as part of the DANDELIONS project, a mobile NO_2 LIDAR system has been built. With this system the NO_2 vertical profile in the Netherlands will be measured routinely in the coming year.
In this contribution NO_2 observations from OMI will be presented, as well as first measurements of the NO_2 LIDAR system.

Ozone Recovery: Indications and Questions (E. C. Weatherhead , S. B. Andersen , R. J. Salawitch)

Column ozone data through 2004 have shown signs of leveling off and in some regions, increases. However, an understanding of the processes governing ozone production, destruction and redistribution is required to be able to interpret these changes as recovery. This talk will review some of the recent data and outline some of the evidence for recovery. The impact of different techniques in detecting recovery will be briefly reviewed. Comparison of the emerging data to a variety of 2-D and 3-D models will be shown to help identify the significance of the recent changes. In some cases, these analyses reveal critical questions which limit our ability to assign attribution to the recent changes. Some of these outstanding questions, such as the role of the solar cycle and polar temperatures will be addressed in the coming years using both total column and vertically resolved ozone data from Aura.

Intercomparisons with the Harvard *In Situ* Water Vapor Instrument in the Tropics during Pre-AVE and Earlier Aircraft Campaigns: Implications for the Seasonal Cycle of Stratospheric Water Vapor and Aura Validation (E. M. Weinstock, J. V. Pittman, D.S. Sayres, J. B. Smith, J. R. Spackman, S. S. Leroy, J. G. Anderson, S. C. Wofsy)

Recent intercomparisons during the Pre-AVE mission in January 2004 and a balloon intercomparison flight in November 2004 reveal systematic differences between in situ and satellite based water vapor instruments that are consistent with the summary intercomparison figure from the 2000 SPARC assessment of UT/LS water vapor. We evaluate a series of intercomparisons of HALOE and frost point water vapor with Harvard water vapor during the Pre-AVE campaign, and of HALOE with Harvard water vapor during the STRAT and POLARIS campaigns. Based on the documented accuracy exhibited by the Harvard in situ hygrometer during these campaigns we illustrate the implications of the differences exhibited by the different instruments for our understanding of the mechanisms that control stratospheric water vapor. While the Harvard University Lyman-alpha hygrometer did not participate in the HALOE water vapor validation campaign, our goal is to actively take part in the Aura validation campaign and simultaneously promote and work toward the establishment of a national calibration facility for incontrovertibly validating the accuracy of in situ instruments, with the initial focus on water vapor.

Aura MLS Sensitivity to Dense Cirrus and Deep Convective Clouds (Dong L. Wu and Jonathan H. Jiang)

It is challenging in satellite remote sensing to separate clouds of different types and at different altitudes. Using MLS 240- and 640-GHz measurements we are able to distinguish upper-tropospheric clouds with crystal size distributions between ~30 to 100s microns in mass-mean diameter (Dmm). The Aura MLS observations show that the clouds with Dmm<~30 and Dmm>~30 microns have distinct global distributions in the upper troposphere, which unveils interesting new aspects of cloud dynamics and processes. Unlike cirrus frequently observed by IR/visible techniques, the MLS Dmm<~30 clouds (dense cirrus) do not occur frequently and globally. On the other hand, the Dmm>~30 clouds, generally containing more ice water content, are mostly of deep convection origin. In this paper we will present recent MLS observations of these clouds, and discuss measurement principles and new clouds features.

Evidence for the End of the Decline in the Stratospheric Ozone Layer (Eun-Su Yang, Derek Cunnold, Ross Salawitch, and Mike Newchurch)

Observations indicate that we have seen the end of major declines in the thickness of Earth's protective ozone layer at low and middle latitudes. Time series of stratospheric ozone measured by the SAGE and HALOE satellite instruments are consistent with total ozone columns obtained from the ground-based Dobson/Brewer/filter network and with the merged Total Ozone Mapping Spectrometer (TOMS)/SBUV satellite measurements. Results derived from the worldwide network of ozonesonde measurements also provide consistent evidence for a slowdown of ozone depletion. Statistical analyses confirm that these changes of ozone loss rates are significant above the 95% confidence level. A photochemical model, constrained by satellite data, is used to show that the declining levels of ozone depletion between 18-25 km altitude are consistent with a leveling off of stratospheric abundances of chlorine and bromine due to the Montreal Protocol and its amendments. Recent observations were obtained during a period of unusually low levels of stratospheric aerosol loading. Present understanding suggests that should a major volcanic eruption occur, chemical reactions initiated by volcanic aerosol that reach the stratosphere will likely lead to short periods of decreased ozone due to anthropogenic halogens. Accurate measurements by AURA instruments will be critical in quantifying the anticipated recovering levels of ozone.

POSTER ABSTRACTS

1. A New Cryogenic Whole Air Sampler for Balloonborne Trace Gas Measurements: Description and Recent Results (Elliot Atlas, Rich Lueb, Roger Hendershot, Verity Stroud, Sue Schauffler

A newly designed cryogenic whole air sampler was launched from Ft. Sumner for its initial engineering flight in 2003, and for a subsequent test flight in Fall, 2004. The current version of the sampler collects 26 samples during controlled balloon descent. Samples were collected roughly every km between 10 and 32 km. Samples are analyzed using gas chromatography/mass spectrometry/ECD/FID for a number of trace gases including CFCs, HCFCs, HFCs, PFCs, halogenated solvents, methyl halides, methane and nitrous oxide. Samples will also be examined for isotopic composition of some of the major trace gases (CO_2, N_2O, CH_4, H_2). This presentation will describe the sampler and present some of the vertical profiles and tracer correlations observed during the flights.

2. Characterizations of and Products from OMI UV1 Measurements – Trevor Beck and Lawrence Flynn

Preliminary measurements from the OMI UV1 detector (270 nm to 310 nm) show low noise and good repeatability. Solar data have been used to make a Mg II Index product to track solar variability. The Index compares well to one produced from SBUV/2 solar data. Comparisons of the solar measurements over time reveal cross-track position dependent changes as large as 1.0%. We also find evidence of the minor cross-track wavelength scale errors noted by other researchers.

The initial Level 1 UV1 Earth-view data had significant stray light contamination (no correction was applied), but the later data with the correction applied has good spectral and cross-track consistency and little correlation with reflectivity channel measurements. Measurement residuals for UV1 Earth-view radiance data were computed by using a forward model and a nadir ozone profile retrieval for an average equatorial scene. The UV1 residual study suggests that the measurements are suitable for retrieving ozone profiles even without further adjustments. A preliminary nadir profile product has been created, based on the 11-channel V8 SBUV retrieval code. We are evaluating the profile product and using it to study the characterization of the UV1 detector.

3. TES Data for Assimilation, Inverse Modeling, and Intercomparison – Kevin W. Bowman

The TES retrieval algorithm estimates an atmospheric profile by simultaneously minimizing the difference between observed and model spectral radiances subject to the constraint that the solution is consistent with an a priori mean and covariance. Consequently, the retrieved profile includes contributions from observations with random and systematic errors and from the prior. These contributions must be properly characterized in order to use TES retrievals in data assimilation, inverse modeling, averaging, and intercomparison with other measurements. All TES retrievals include measurement and systematic error covariances along with averaging kernel and a priori vector. We illustrate how to use these TES data with a couple of examples from a simulated CO source estimation and comparison of TES ozone retrieval to the GEOS-CHEM chemical transport model.

4. Infrared Spectrometer Observations during the Polar Aura Validation Experiment (PAVE) – Michael T. Coffey and James W. Hannigan

5. Ozone Monitoring Instrument in-flight Calibration Results – Marcel Dobber

The Ozone Monitoring Instrument (OMI) was launched on board of the EOS AURA satellite on 15 July 2004. OMI is a hyperspectral sensor that measures in the wavelength range 270-500 nm with a spatial resolution of 13x24 km2 for wavelengths above 305 nm and 13x48 km2 below 305 nm. The 115 degrees instantaneous field of view covers about 2600 km at the equator, which enables daily global coverage of the Earth.

OMI is capable of measuring the total ozone and nitrogen dioxide columns, ozone vertical profiles, cloud properties, aerosol indices and a number of trace gases that are important to ozone chemistry. Furthermore, OMI is continuing the total column ozone record of the Total Ozone Mapping Spectrometer (TOMS), operated by NASA over the past 25 years. In order to obtain the required quality of the level-1 (calibrated radiances and irradiances) and level-2 data products it is important to calibrate the instrument accurately both pre-launch and in orbit. This contribution presents a number of OMI in-flight calibration results. The radiometric calibration of both the radiance and irradiance modes, spectral calibration, spectral slit function calibration, viewing properties calibration and spectral stray light calibration are discussed. In addition a number of detector and electronics calibration parameters are presented.

6. Measurements of Air-Broadened Linewidths for MLS – Brian J. Drouin

Temperature dependent air-broadened linewidth measurements have continued at JPL in support of the MLS onboard Aura. A sideband spectrometer has been built around the Balloon OH instrument and has been utilized in an all-vacuum laboratory apparatus to measure spectral properties of atmospheric species within the bandwidth of the 2.5-THz radiometer (R5). The system has enough sensitivity to observe OH absorption directly and ozone via frequency modulation. Linewidths of reasonable accuracy have been measured for these species; however, any pressure dependent lineshift is masked by the slow frequency drift of the laser-local oscillator. Attempts to validate or improve the sideband measurements utilizing frequency multiplier technology available from the Herschel program are underway. Measurements of HCN and HNO_3 air-broadened linewidths for the 190-GHz radiometer (R2) have been completed using the conventional linewidth apparatus.

7. Global Self-Validation of Aura Data – Timothy J. Dunkerton and Richard K. Scott

We describe a new system of validation, "global self-validation" (GSV), designed to check internal consistency of satellite data with the known fluid dynamical properties of the region sampled. The system is based on the simple concept of advection, by analyzed winds, of constituent observations between spatially and temporally separated satellite footprints. In contrast with traditional validation methods, our method does not rely on independent observations. What makes the system feasible now is the unprecedented sampling rate and spatial coverage of the Aura satellite, which allows advective timescales to be kept much shorter than the timescales of flow evolution. In addition to validation, the methodology has direct applications to the investigation of transport processes and constituent sources and sinks in the UT/LS.

To illustrate the use of the GSV system we describe two preliminary applications, using, respectively, synthetic model data and GOES water vapor imagery. In the first application, a simple dynamical model generates a high resolution tracer field representative of the UT/LS, which is subsequently sampled asynoptically, and at a reduced resolution, analogously to the satellite soundings. We then apply the backward integration procedure of the GSV system to construct synoptic tracer fields at various times and compare these with the full model fields. In this case, errors are controllable, being entirely limited to those introduced by the sampling or by non-advective terms in the model (e.g. diffusion). The effect of these errors on the accuracy of the reconstructed synoptic tracer field can therefore be evaluated. This application highlights the benefits obtained from improved spatio-temporal sampling by the Aura satellite.

In the second application, we make use of high resolution (synoptic) water vapor imagery from GOES satellites. The observed tracer field at a given time is compared with reconstructed fields obtained by forward advecting earlier observations with ECMWF analyzed winds for a short (and variable) time period over a limited region. In this case, errors arise from the lack of knowledge of the vertical water vapor profile and from diabatic and moist processes missing from the advection. Using a combination of advection on different isentropic levels and over varying time intervals we consider the contributions of these errors to errors in the reconstructed tracer field. This application highlights some issues relevant to the retrieval of vertical profiles and partial column amounts of trace constituents, especially of ozone and water vapor in the upper troposphere.

8. Gravity Waves, Ozone, and Polar Stratospheric Clouds: Forecasting, Modeling and MLS/DC-8 Measurements during the Polar AURA Validation Experiment of January-February 2005 – Steve Eckermann, John McCormack, Dong Wu, Jonathon Jiang, Michelle Santee, Jun Ma, Ag Stephens and Bryan Lawrence

As part of the overall forecasting support for the Polar AURA Validation Experiment (PAVE) of January-February 2005, we forecast the upper troposphere and stratosphere over the PAVE area of DC-8 operations using a suite of global numerical weather prediction (NWP) models (ECMWF, NOGAPS) and mountain wave prediction models (MWFM, 3DLOM, Fourier-ray codes): see http://uap-www.nrl.navy.mil/dynamics/html/pave-7646.html. We review some preliminary scientific findings resulting from this work, including: (a) case study comparisons between observed and NWP ozone along flight tracks, as a test of ozone predictive skill in current operational NWP systems; (b) relationships among cold stratospheric temperatures, mountain waves, ozone, and polar stratospheric clouds over Greenland, including some preliminary comparisons with MLS data.

9. An Exploratory Study to Use OMI Total Ozone Data in Near-Real-Time to Produce a Guidance Product for Air Quality Forecasters – Jack Fishman, Donna P. McNamara, James J. Szykman, Amy E. Wozniak and John K. Creilson

Using total ozone measurements from OMI, we plan to develop a near-real-time (NRT) product that will benefit air quality forecasters and will contribute to our understanding of how widespread ozone pollution episodes evolve. The product is based on the tropospheric ozone residual (TOR) methodology that subtracts a stratospheric column ozone (SCO) distribution from the total ozone distribution derived from OMI measurements. To derive the SCO, we will integrate the forecasted ozone distribution using NOAA's Global Forecast System (GFS) model at the coincident time of the OMI overpass over the eastern U.S. Once the TOR product is available, ensembles of trajectories from NOAA's HYSPLIT (Hybrid Single-Particle Lagrangian Integrated Trajectory) model will be computed to define areas where potentially high ozone concentrations at the surface are likely to occur. Because the TOR product does not define the altitude of elevated ozone concentrations within the troposphere, a significant part of our initial research will be the analysis of ozonesonde data from retrospective studies to understand the relationship between high TOR and its vertical distribution over the eastern U.S. and also to the distribution of surface ozone concentrations. During summer 2006, the product will be evaluated by the NESDIS Satellite Analysis Branch and we will distribute the forecasted ozone product to a selected group of air quality forecasters (from local/regional EPA agencies) so that it may be used as additional guidance when these forecasters prepare their air-quality prognoses. After this season of trials, we will assess how the forecasters used the information provided to them and how our ozone product improved their forecast products. The product will undergo additional refinement for another trial during summer 2007.

10. Preliminary Results from SOWER Water Vapor Match Trials in the Campaign December 2004 to January 2005 – F. Hasebe, N. Nishi, A. Hamada, M. Shiotani, M. Fujiwara, Y. Inai, H. Voemel, T. Shibata, S. Ogino, T. Thanh, S. Saraspriya, N. Komala, S. Kaloka, S. Hamdi, R. Scheele, P. Fortuin, and S. Oltmans

Effectiveness of the "cold trap" dehydration could be examined by observing the water vapor mixing ratio of the same air mass twice or more during its excursion in the TTL of the western Pacific (water vapor match). Trials have been made during the SOWER campaign in December 2004 to January 2005, in which chilled mirror water vapor sondes (Snow White or University of Colorado Cryogenic Frostpoint Hygrometer) are launched with ECC ozone sondes at stations in Tarawa, Biak, Bandung, Ha Noi and the research vessel "Mirai" quasi-stationed near Palau. The TTL cirrus has been monitored by the lidar in Bandung whenever possible. Additional data such as those of lidar and radiosondes may be supplied from "Mirai" cruising team. Isentropic and kinematic trajectories are forecast based on the ECMWF and NOAA analyses. The wind field during most of the campaign period was favorable for catching the match pairs with the above network. Results from some preliminary analysis will be presented.

11. Cloud Property and Its Implications to Water Vapor Transport Mechanisms over Tibetan and Asian Monsoon Region from "A-Train" Observations – Yuanlong Hu, Rong Fu, Jonathan Wright, and Jonathan H. Jiang

Cloud data from Aura MLS and EOS Aqua and Terra MODIS (MODerate resolution Imaging Spectroradiometer) are used to investigate the cloud property and the underlining transport mechanisms in the upper tropospheric atmosphere during late August and early September 2004. Two targeted regions, one encompassing the eastern Tibetan plateau and its southeast surroundings (10N-35N, 90E-105E), and the other encompassing the Indian subcontinent and northern Indian Ocean (15N-30N, 75E-90E), were chosen to reflect different meteorological background settings (i.e., the South Asian Anticyclone and Indian monsoon). MODIS level 2 cloud data product consists of cloud optical and physical parameters such as effective particle radius, cloud phase (ice/water/mixed), cirrus reflectance, optical thickness, etc. Since the effective particle radius is derived from visible radiances, it is only available during the daytime. Aura MLS observes ice water contents during both day and night. Following the "A-Train," on average, the two regions are scanned by about seven granules from either Aqua or Terra with five minutes apart for the adjacent granules. The time all three observations (Aura MLS, Aqua, and Terra) are likely co-located is in the early morning (UTC). For instance, the targeted Tibetan region was first scanned through by Terra around 4 am, followed by Aqua around 6:30 am, and then Aura MLS around 6:45 am. Both MODIS ice cloud effective radius and MLS ice water content suggest that the ice particles are significantly smaller over the Tibetan plateau region than over the Indian subcontinent. How this difference in cloud microphysical property may link to the differences in convective and large-scale transport processed between these two regions is under investigation, and preliminary results will be presented.

12. Stratospheric H_2O Measurements from Aura MLS – C. Jimenez, H. Pumphrey, and R. S. Harwood

The microwave limb sounder (MLS), one of the 4 instruments on board the satellite Aura, detects emission from the 183.3 GHz line in order to provide the water vapor distribution in the middle atmosphere (10-90 km). Since the first data came in August 2004, efforts have been concentrated on the removal of artifacts and on conducting a preliminary validation of the product. The after-launch retrieval code (v01.46) has been extensively revised, and the resulting new version of the code (v01.50) has greatly improved the water vapor product, to the extent that the data is nearly ready for a first public release. The improvement in the data has been monitored by internal consistency tests, for instance, by following the degree of fitting between measured and forward modeled radiances, and by external comparisons with data from other instruments, such as HALOE or SAGE-II. The preliminary validation of v01.50 shows reasonable agreement with HALOE; for instance, bias between both water vapor products are smaller than 0.5 ppmv for most of the stratosphere. Further efforts will concentrate on a more extended validation of the product and newer revisions of the retrieval code to tackle possible artifacts in the data that are uncovered by the validation or further internal tests.

13. Influence of Isentropic Transport on Seasonal Ozone Variations in the Lower Stratosphere and Subtropical Upper Troposphere – P. Jing, D. M. Cunnold, E.-S. Yang, and H.-J. Wang

The isentropic cross-tropopause ozone transport has been estimated in both hemispheres in 1999 based on the potential vorticity mapping of Stratospheric Aerosol and Gas Experiment II ozone measurements and contour advection calculations using the NASA Goddard Space Flight Center Global and Modeling Assimilation Office analysis. The estimated net isentropic stratosphere-to-troposphere ozone flux is ~118±61 ×109 kg/yr globally within the layer between 330 and 370 K in 1999, and 60% of it is found in the Northern Hemisphere and 40% in the Southern

Hemisphere. The monthly average ozone fluxes are strongest in summer and weakest in winter in both hemispheres. We argue that isentropic transport is likely to be important for determining ozone levels in the subtropical upper troposphere especially in summer.

14. Aura MLS Cloud Measurements: Results from First Six Months in Orbit – Jonathan H. Jiang, Duane E. Waliser, Dong L. Wu

The Aura Microwave Limb Sounder (MLS) upper tropospheric cloud measurements are made simultaneously with water vapor, temperature and a number of chemical tracer measurements. This important capability, unique to MLS, provides valuable new data for quantifying processes affecting the water budget in the upper troposphere and lower stratosphere and its potential effect on climate change. Interactions between clouds and anthropogenic pollution could also be investigated with MLS cloud measurements in the polluted areas. In this poster presentation, we'll present results of MLS cloud measurements from August 2004 to January 2005. Many interesting patterns have been identified during this period, including summertime deep convection patterns in subtropics and wintertime storms at mid-latitudes. We'll also show preliminary comparisons between GCM simulated and MLS measured cloud ice during October-December 2004. This example could provide clues as how MLS measurements can be used as a constrain for the model.

15. A Cavity Enhanced Near-Infrared Spectrometer for Airborne Trace-Level Water Isotope (^{2}H, ^{17}O, and ^{18}O) analysis: DC-8 test flights – H. J. Jost, Iannone, Romanini, Kerstel

In May 2004 engineering test flights aboard the NASA DC-8 were performed with our water vapor isotope ratio spectrometer. The device is a cavity enhanced, near infrared, tunable diode laser spectrometer with no need for cryogens. The core optical part weighs only about 3.5 kg. Based on a preliminary analysis of a flight segment at 41,000 ft with a total water concentration of approximately 200 ppm, we estimate the precision for 10-second integration time to be 1≈, 3≈ and 10≈ for ^{18}O, ^{17}O and ^{2}H, respectively. We present the design of the device, initial results from the test flights and an outlook on Aura supporting science opportunities.

16. Chemistry/Transport Modeling for the Polar Aura Validation Experiment – S. R. Kawa, P. A. Newman, M. R. Schoeberl, A. R. Douglass, T. McGee, N. Livesey, L. Froidevaux, J. Waters, ASUR Team

The Polar Aura Validation Experiment (PAVE) conducted in January and February 2005 was fortunate to take place in an unusually cold and stable northern hemisphere winter. The cold temperatures produced significant polar stratospheric cloud formation, chlorine processing, and ozone loss providing a relatively wide dynamic range of several key measured constituents (ClO, HCl, HNO_3, N_2O, O_3, H_2O) in the lower stratosphere. We have simulated this period with the Goddard stratospheric chemistry/transport model (CTM), using transport fields from meteorological data assimilation. The model can aid the validation effort by providing a consistent point of reference between satellite and validation measurements at non-coincident times, locations, and observation geometries. The model also provides a synoptic global view of the chemical distributions, measured and not, and a complete time series of constituent field evolution. In addition, constituent forecasts were produced using forecast meteorological data for flight planning purposes. This presentation will give an overview of the 2004/2005 polar winter from the global CTM perspective and will compare CTM output with Aura and DC-8 data to evaluate the consistency between the data sets for a variety of chemical species.

17. Atmospheric Composition Data and Information Services Center (ACDISC) – Steve Kempler

NASA's GSFC Earth Sciences (GES) Data and Information and Data Services Center (DISC) manages the archive, distribution and data access for atmospheric composition data from AURA's OMI, MLS, and hopefully one day, HIRDLS instruments, as well as heritage datasets from TOMS, UARS, MODIS, and AIRS. This data is currently archived in the GES Distributed Active Archive Center (DAAC).

The GES DISC has begun the development of a community driven data management system that's sole purpose is to manage and provide value added services to NASAs Atmospheric Composition (AC) Data. This system, called the Atmospheric Composition Data and Information Services Center (ACDISC) will provide access all AC datasets from the above mentioned instruments, as well as AC datasets residing at remote archive sites (e.g, LaRC DAAC)

The goals of the ACDISC are to:

- Provide a data center for Atmospheric Scientists, guided by Atmospheric Scientists
- Be absolutely responsive to the data and data service needs of the Atmospheric Composition (AC) community
- Provide services (i.e., expertise) that will facilitate the effortless access to and usage of AC data
- Collaborate with AC scientists to facilitate the use of data from multiple sensors for long-term atmospheric research

The ACDISC is an AC specific, user driven, multi-sensor, on-line, easy access archive and distribution system employing data analysis and visualization, data mining, and other user requested techniques that facilitate science data usage.

The purpose of this presentation is to provide the evolution path that the GES DISC in order to better serve AC data, and also to receive continued community feedback and further foster collaboration with AC data users and providers.

18. Aura Validation Using Statistical Methods That Do Not Require Correlative Measurements to Be Co-Located in Space and Time – David Lary

Validation of Aura measurements of trace gases is underway using statistical methods that do not require correlative measurements to be co-located in space and time. Our proposed work will evaluate the quality of level 2, long-lived trace species (O_3, H_2O, CH_4, and N_2O) in the upper troposphere and lower stratosphere (10-25 km). Techniques we have developed working with CLAES UARS, and aircraft, and balloon data will be applied to Aura measurements. We apply statistical methods developed for non-collocated measurements to evaluate consistency among Aura instruments as well as their agreement with other data sets. A key feature of this work is putting the observations of Aura in their long-term historical context via statistical comparisons with previous datasets collected over more than a decade. To validate the Aura data, we will use data from solar occultation (Canadian ACE) and limb sounder satellite instruments as well as from ozonesondes, lidar, and aircraft instruments (AVE and MOZAIC). This statistical analysis is also being used as preparation for full Kalman filter chemical assimilations.

19. Diagnostics for TES Initial Observations – M. Lampel, H. Worden, R. Beer, K. Bowman, A. Eldering, M. Gunson, M. Luo, G. Osterman, S. Sund Kulawik, J. Worden

Metrics for data quality of observations are analyzed with respect to several parameters determined from Level 2 processing. Data quality parameters include retrieval success, mean residuals, RMS residuals, number of degrees of freedom of data and a set of frequency scale parameters (calscale). We present and discuss initial data quality information from these observations. Overall success for these initial observations is excellent with nearly 100% of data processed through Level 2 for the special observations and over 90% for the global survey.

20. TES Science Standard Data Products – Scott Lewicki

This poster will display the format and contents of the TES Science Standard Data Products at Level 1B and Level 2. Information on ordering these data products and tools and services available for manipulating these data products will also be described.

21. Measurements of Nitrous Oxide from the Aura Microwave Limb Sounder – N. J. Livesey, G. L. Manney, H. A. Michelsen, M. L. Santee, W. G. Read, J. W. Waters

This paper will review the observations of nitrous oxide (N_2O) from the Microwave Limb Sounder (MLS). A review is given of the quality of the MLS N_2O observations as described by estimates of precision, resolution and provisional accuracy. In addition, comparisons with other observations and model datasets will be shown. The use of MLS N_2O observations as a tracer of stratospheric motions will be illustrated for the case of the 2004 southern and 2004/2005 northern winter polar vortices.

22. The UT/LS CO:O_3 Correlation and Implications for Cross-Tropopause Transport from *In Situ* Observations in Several Field Campaigns, Including PreAVE (January 2004) and October AVE (October/November 2004) – Max Loewenstein, Hansjürg Jost, Jimena Lopez, *et al.*

This presentation, in addition to presenting several new data sets, will include a discussion of cross tropopause transport as deduced from the CO:O_3 correlation observed in the UT/LS region at several latitudes and seasons.

23. Comparisons of Preliminary OMI Profile Ozone Products with Those from SBUV/2 – Craig S. Long, Trevor Beck, Larry Flynn, Shuntai Zhou, Alvin J. Miller

Although the algorithms to produce the nadir profile ozone products from the OMI are still in the preliminary stage, these data provide the first opportunity to examine the nature of the OMI data and the influence of the increased resolution of the full-scan data. This poster will provide an initial comparison between the nadir ozone products (total ozone and ozone profile data) from OMI with that from the NOAA-16 SBUV/2. The orbits are very similar (ascending - 1:40 vs.

2:00 pm equator crossing) allowing for several overlapped orbits every other day. Data from this past December 2004 will be utilized and the similarities and differences will be presented.

24. TES Measurement of CO and Preliminary Comparisons to MOPITT, MLS, AVE, and Model Results – M. Luo, C. Rinsland, S. Sund-Kulawik, A. Goldman, R. Beer, S. Clough, H. Worden, J. Worden, G. Osterman, M. Gunson, D. Rider, S. Sander, M. Lampel, Q. Li

The Tropospheric Emission Spectrometer (TES) on-board Aura satellite makes measurements of atmospheric spectral radiance covering 4.7 um band of CO in both nadir and limb modes. In this paper we will present the preliminary assessment on the CO spectra, the initial results of CO retrievals and characteristics, and limited comparisons with other observations, including MOPITT, MLS in the upper troposphere and the in-situ measurements from Argus of AVE. We will also show comparisons with GEOS-CHEM model simulations. Discussions on future validation plans will be given.

25. OMI-EOS Research Programme at the Finnish Meteorological Institute: UV, Validation, Very Fast Delivery and Ozone Profiles from Occultation Instruments – A. Mälkki, G. W. Leppelmeier, J. Tamminen, A. Tanskanen, E. Kyrölä, E. Kyrö, O. Aulamo, and N. A. Krotkov

For the OMI-EOS instrument on EOS-Aura, Finnish industry, led by the Finnish Meteorological Institute (FMI), has provided the Electronics Unit as well as the Detector Modules. In the operational phase of the mission, FMI will conduct its research on OMI data in close collaboration with KNMI, NASA and other members of the International OMI Science Team. The specific contributions from Finland are the UV product, with heritage from the TOMS UV product, the Direct Broadcast receiving and processing to Very Fast Delivery products in Sodankylä (68 degrees North, 25 degrees East) as well as combining the OMI data with GOMOS data from ENVISAT, OSIRIS from Odin spacecraft, and active participation in the OMI validation programme.

For the OMI-EOS Science Programme, the FMI main components will be Global UV product processing, Direct Broadcast products over Western Europe, O_3 and UV product validation, as well using the OMI data together with the GOMOS and OSIRIS measurements to obtain a 4-dimensional picture (3D + time) of the middle atmosphere O_3 fields.

26. An NARCM Simulation of Aerosol-Cloud Interaction over Southwest Asia: Initial Results and Comparison with Aura MLS Observations – R. Munoz-Alpizar, J.H. Jiang, J.P. Blanchet, Qinbin Li

A 3-D Northern Aerosol Regional Climate Model (NARCM) is used to investigate the potential effect of aerosols on upper-tropospheric clouds observed by Aura MLS over southwest China in August-September 2004. NARCM is composed of dynamical and physical modules that incorporate size and species segregated aerosol physics (production, transport, growth, coagulation, and dry and wet deposition) and chemistry. The model simulates the composition, size distribution and concentration of the aerosols injected from the PBL into the upper troposphere and the subsequent enhancement of cloud formation. The results provide initial evidence that aerosols may be responsible for the formation of some of the dense high-altitude clouds observed by MLS.

27. Tropospheric Ozone Lidar and Ozonesondes at RAPCD for Aura Validation – Mike Newchurch, David Bowdle, John Burris, Bill Irion, Steven Johnson, Mike Gunson, and Rich McPeters

We propose to operate lidars and launch ozonesondes at the Regional Atmospheric Profiling Center for Discovery (RAPCD) in Huntsville, AL for AURA validation. The lidars include an Ozone UV DIAL lidar for free-tropospheric ozone and an Nd:YAG scanning lidar for aerosol backscatter profiles for aerosol profiles and for corrections in the ozone retrievals. The focus of this work is validation of Aura OMI and TES tropospheric ozone observations within windows of coincident lidar and ozonesonde observations centered on the AURA times of measurements. We will also use ozone observations from TOMS and AQUA/AIRS and from the worldwide network of ozonesonde, Dobson, and Brewer stations for pair-wise comparisons of ozone profiles in the context of the spaceborne averaging kernels. The expected results are an assessment of the accuracy of the satellite tropospheric ozone measurements. These observations will also facilitate studies of transport of regional pollution plumes in the free troposphere.

28. Initial Measurements of Total and Tropospheric Column Ozone by TES – G. B. Osterman, S. S. Kulawik, J. Worden, A. Eldering, H. M. Worden, K. W. Bowman, M. Luo, D.M. Rider, B. Fisher, M. Lampel, Q. Li, M. R. Gunson, and R. Beer

We show total ozone column amounts measured by the Tropospheric Emission Spectrometer (TES). Initial comparisons are made between the TES column ozone results and other satellite measurements. We also show TES measurements of the ozone column amount in the troposphere for a variety of different atmospheric conditions.

29. GEOS-4 Meteorological Analyses and Forecasts in Support of the Aura Mission – Steven Pawson, Wei-Wu Tan, Gloria L. Manney, J. Eric Nielsen, S. Randolph Kawa

Meteorological products from the Goddard Earth Observation System, Version 4 (GEOS-4) modeling and assimilation system are being provided to the EOS-Aura mission. This paper will discuss the GEOS-4 analyses and forecasts, in the context of the Aura mission and for the Polar Aura Validation Experiment (Pave). The foci of discussion will be: (i) The quality of the analyses in the 200-10 hPa region of the atmosphere, including the agreements with the observed data (sondes and nadir radiances); (ii) Comparative assessments against other analyses (e.g., National Centers for Environmental Prediction); (iii) The success of the two-, five- and ten-day forecasts in predicting the cold vortex and its possible breakup. For Pave, a customized forecasting system has been set up, including a full stratospheric chemistry module; if time allows, results of these chemical forecasts will also be shown. Validation against independent data (i.e., those not included in the assimilation), such as limb-sounder measurements, will be presented.

30. Validating Remote Sensing Measurements of Ice Water Content: Evaluating Flight Plan Requirements Based on *In Situ* and Modeled Data – David S. Sayres, Jasna V. Pittman, Jessica B. Smith, Elliot M. Weinstock, James G. Anderson, Ann Fridlind, Andrew S. Ackerman, Gerry Heymsfield, and Lihua Li

One of the major goals of the 2002 CRYSTAL-FACE mission was to intercompare and validate measurements of cloud microphysical quantities by a variety of remote and in situ instruments.

However, based on established overlap criteria, a direct comparison of remote and in situ measurements during the month long campaign only yielded 20 minutes of usable data. Clearly, if A-Train data products are to be calibrated and validated using in situ measurements, flight plans are required that maximize that amount of overlap data between in situ and remote sensing instruments. Because of the difficulties of attaining adequate overlap as exemplified during CF, the option of using a statistical approach for validating remote IWC retrievals is investigated using a cloud microphysics model. We also use the model to evaluate the intercomparison requirements and create flight plans that will allow for a direct comparison approach.

31. The Ticosonde-NAME 2004 Program of High-Frequency Radiosonde Measurements over Costa Rica – H. B. Selkirk, W. Stolz, E. Zarate, P. Manso, J. Amador Astua, W. Fernandez Rojas, J. Valdés Gonzales, J. A. Diaz Diaz, L. Pfister, L. Miloshevich, K. Heinrich Bettoni

Ticosonde/NAME 2004 is a collaboration between NASA, the North American Monsoon Experiment (NAME), the Instituto Meteorológico Nacional and four other academic and scientific institutions in Costa Rica and to characterize the vertical structure and temporal variability of the atmosphere over Central America during summer of 2004. Sonde ascents were made four times per day (00, 06, 12 and 18 UT) from Juan Santamaria International Airport (WMO station 78762) between June 16 and September 6, 2004. Over 300 successful ascents were made over the course of the 83-day program with Vaisala GPS rawinsondes, of which 220 were made with the RS-90 AG sonde equipped with the dual-humicap system for measuring relative humidity; the remaining ascents used the RS80-15G sonde. Despite the frequent presence of deep convective clouds, most of the sondes ascended well into the stratosphere, with an average burst altitude of over 23 km or 30 hPa. Data every two seconds were archived from the sondes, permitting the future application of corrections to remove the known time-lag errors in the RS-90 humicap system. Since ascents were routinely made within 90 minutes of both the ascending and descending nodes of the Aqua satellite, the corrected data will provide an opportunity to validate the AIRS water vapor measurements, particularly in the tropical tropopause layer, where accurate humidity measurements are not obtained on a routine basis.

The authors have proposed a second Ticosonde campaign in the summer of 2005 to begin with the Tropical Cloud Systems and Processes (TCSP) field campaign, tentatively scheduled to commence on June 15. This new effort will be called Ticosonde-TCSP 2005. If supported, Ticosonde-TCSP 2005 will launch Vaiasala RS-92 sondes times daily from Juan Santamaria International Airport, and corrections will be applied to the humidity measurements. Additionally, the humidity measurements from the 2004 campaign will be corrected. During TCSP, we hope to collaborate with Dr. Holger Voemel of the University of Colorado who has proposed 30 daily ascents of his Cryogenic Frostpoint Hygrometer (CFH)-ozonesonde payload. The corrected Ticosonde-TCSP 2005 humidity data will provide an unprecedented opportunity to acquire a high-frequency data of accurate upper tropospheric water vapor.

In addition to a discussion of the potential utility of the Ticosonde measurements for validation of instruments on both the Aqua and Aura satellites, we report on various aspects of the vertical structure and temporal variability from the 2004 campaign, with an emphasis on the effects of the prominent diurnal cycle in cloudiness and rainfall in the Valle Central of Costa Rica where the sonde site is located.

32. *In Situ* Measurements of Ice Water Content on the NASA WB-57F during MidCiX: Implications for MLS and CloudSat Validation – J. Ryan Spackman, David S. Sayres, Jasna V. Pittman, Jessica B. Smith, Elliot M. Weinstock, James G. Anderson, Cynthia H. Twohy, Gregory Kok

Accurate measurements of ice water content (IWC) of cirrus clouds in the upper troposphere are important to characterizing dynamics and radiative processes in the UT/LS region. The Harvard Total Water instrument and the Oregon State Cloud Spectrometer and Impactor (CSI) perform in situ measurements of total water and ice water content, respectively, with independent sampling and detection techniques. Harvard Total Water has flown aboard the NASA WB-57F aircraft since 2001 and has been subjected to the same rigorous laboratory calibrations as the Harvard Water Vapor instrument. Yielding high-quality data from the Cessna Citation during previous missions, CSI was integrated into the WB-57F payload for the first time during MidCiX (Middle Latitude Cirrus Experiment, Ellington Field, Texas, April–May 2004), providing an opportunity for extensive intercomparisons of IWC in the upper troposphere. Water vapor data from the Harvard Lyman-α hygrometer, flown simultaneously, are used in conjunction with the Harvard Total Water data to derive IWC. The results of this intercomparison can help to better assess how to perform validations of the IWC retrievals from MLS and CloudSat.

33. SHADOZ (Southern Hemisphere Additional Ozonesondes) Accomplishments, Status, and Strategies in the Aura Period – Anne M. Thompson, Jacquelyn C. Witte, Samuel J. Oltmans, and the SHADOZ Team

Profiles from the Southern Hemisphere ADditional OZonesondes (SHADOZ) project, taken with electrochemical concentration cell (ECC) ozonesondes and standard radiosondes are essential for refinement of the TOMS (and emerging OMI) algorithms. The data are archived at: <http://croc.gsfc.nasa.gov/shadoz>. Discrepancies between the version 8 algorithm and integrated total ozone from the sondes have decreased 1-2% in absolute amount compared to version 7 TOMS. Improvements to the tropospheric part of first-guess ozone profiles used in satellite retrievals is facilitated by the regularity of launches and by the zonal distribution of SHADOZ stations [Thompson et al., *JGR,* 108, 8241, doi: 10.129/2002JD002241, 2003]. Normalization to a SHADOZ-defined "mean" tropical profile displays small, systematic variations in stratospheric ozone among some of the stations. These biases can largely be understood in terms of variations in sonde technique and manufacturer as evident during a WMO comparison of SHADOZ methods in JOSIE-2000 (Jülich Ozonesonde Intercomparison Experiment) chamber tests. As we transition to Aura the emphasis of existing SHADOZ stations is to launch at the satellite overpass. Profiles from surface to balloon burst in tropical and subtropical locations will be provided within 2-3 weeks of launch to all Aura instrument Teams (MLS, HIRDLS, OMI and TES). Selected stations are expected to join SHADOZ. Priorities are given to undersampled regions (west Africa; central America; southern Asia), areas where tropospheric ozone algorithms tend to disagree and regions of high aerosol loading. SHADOZ data are sent to the Aura Validation Data Center (AVDC) as required by protocol and transmitted annually to the World Ozone-UV Data Centre in Toronto (Downsview), Canada.

34. First Results from the OMI Cloud Pressure Algorithm Based on UV Measurements – Alexander P. Vasilkov and Joanna Joiner

The OMI cloud pressure product is necessary for the correction of the OMI mission-critical total column ozone product as well as for the accurate determination of tropospheric ozone and potentially other trace-gases by cloud-slicing methods. An effective cloud pressure is derived from the high frequency structure of the top-of-atmosphere reflectance in the UV caused by rotational Raman scattering (RRS) in the atmosphere. RRS results in filling-in of Fraunhofer lines in the backscatter UV spectra. Clouds reduce the amount of filling-in of Fraunhofer lines, with the amount of filling-in related to the cloud pressure. The cloud pressure algorithm retrieves the effective cloud pressure and cloud fraction using a concept of the Mixed Lambert Equivalent Reflectivity (MLER). The MLER concept is also used for several of the OMI algorithms including the retrieval of ozone and other trace gases. Initial results of retrieving cloud pressures from OMI data are presented. A soft calibration technique applied to the OMI data is described. Preliminary validation of our cloud pressures is being carried out by comparing with (1) cloud-top pressures and properties derived from Aqua MODIS infrared data and (2) cloud properties from the Cloud Physics Lidar (CPL) flying on the WB-57 aircraft as part of the Aura Validation Experiment (AVE) field campaign. We also compare our cloud pressures with those retrieved from OMI visible data with the O2-O2 absorption algorithm.

35. Total Ozone from OMI Using the DOAS Method: First Results and Preliminary Validation – J. P. Veefkind, J. F. de Haan, E. J. Brinksma, M. Kroon, P. K. Bhartia, K. Yang, and P. F. Levelt

The OMI instrument combines an unprecedented spatial resolution of 13x24 km^2 at nadir with daily global coverage. The high spatial resolution and daily global coverage are especially important for observing the troposphere, where the variations of trace gases and aerosols are large in both space and time. To derive information on tropospheric ozone, the total column ozone has to be measured with a very high accuracy.
The international OMI science team brings together the heritage form TOMS and the heritage from the DOAS ozone measuring techniques. By applying both methods on the OMI data, it is anticipated that we can further improve the total column measurements from OMI. Initial results show that there is good agreement between the TOMS and DOAS type retrieval from OMI. The main differences are in regions with thick clouds, at high solar zenith angle and over bright surface such as snow and ice. Comparisons will be shown between OMI-TOMS and OMI-DOAS data. Also preliminary validation results will be presented.

36. CO_2, CH_4, and CO Column Abundances Retrieved from Ground-Based Near-Infrared Solar Spectra – Rebecca Washenfelder

37. Resonance Fluorescence Instrument for the *In Situ* Detection of BrO in the Atmosphere – David M. Wilmouth, Richard M. Stimpfle, and James G. Anderson

Losses of ozone over midlatitudes of the northern hemisphere are well documented in both the scientific literature and the public policy arena. Accurately defining secular trends in the distribution of ozone and establishing the mechanisms responsible for the observed losses are two dominant and enduring issues. The latest WMO report, Scientific Assessment of Ozone Depletion: 2002, states: "The vertical, latitudinal, and seasonal characteristics of changes in midlatitude ozone are broadly consistent with the understanding that halogens are the primary cause of these changes, in line with similar conclusions from the 1998 Assessment." Other studies, however, have indicated alternative explanations to midlatitude ozone loss. Therefore, given the continued uncertainty, it is prudent to examine the full complement of halogen radical families in the lower stratosphere from the tropics to midlatitudes. Accurate BrO measurements, in particular, are critical due to the high efficiency of bromine compounds at ozone destruction. However, efforts to test the abundance and speciation of bromine in the stratosphere have been particularly hampered by low atmospheric concentrations. Here we present details of an instrument capable of making sensitive in situ atmospheric measurements of BrO.

38. Validation of Aerosol Products with Accurate *In Situ* Aerosol Measurements: SAGE II, SAGE III and POAM II – James C. Wilson and J. Michael Reeves

Aerosol particles play a significant role in the physics, chemistry and optics of the upper troposphere and lower stratosphere (UT/LS). Particles serve as nuclei for the formation of clouds that strongly impact the Earth's radiation budget. Particles host heterogeneous reactions that impact the partitioning of the chlorine family, reactive nitrogen species as well as OH and HO_2 in the lower stratosphere. These species play important roles in ozone destruction. Thus, it is important to understand the abundance of aerosol in order to understand ozone depletion and the Earth's radiation budget. In addition, it is important to predict the evolution of the aerosol as emissions of aerosol and precursors change.

Satellites provide information with global coverage concerning the abundance and characteristics of particles. This information will contribute significantly to understanding and predicting future aerosol abundance. Extracting accurate aerosol information from remote measurements is quite challenging. The work in progress under this grant provides comparisons of aerosol properties provided by three solar occultation satellite instruments with the results of in situ measurements made using a Focused Cavity Aerosol Spectrometer (FCAS) (Jonsson et al., 1994) operated by the University of Denver Aerosol Group on NASA ER-2 and DC- 8 aircraft. The FCAS measurements were made at near- coincidences with the satellite measurements.

The satellite instruments, SAGE II, SAGE III and POAM III, provide optical extinctions at several wavelengths which are attributed to aerosol. Gaseous species contribute extinction at the reported wavelengths and the solar occultation satellites are looking along a chord passing through the atmosphere. Thus, these products are the result of processing of the satellite measurements and involve uncertainties that are estimated and reported. The FCAS measures light scattered by individual particles as they pass through a laser beam in the instrument which has flown on NASA research aircraft. These particles are sampled from the ambient, transported to the instrument and measured during flight. Since the aerosol sample is modified in sampling and transport and since the measurement is subject to uncertainties, the reported ambient size distributions have uncertainties associated with them. They are used to calculate extinctions at the wavelengths reported by the satellite instruments

In addition, SAGE II reported aerosol surface area concentrations retrieved from the extinction data. We have made comparisons with the relevant FCAS measurements to evaluate these retrievals.

Conclusions:

1) In most instances, the FCAS extinctions were in agreement with the SAGE II, SAGE III and POAM III extinctions. This agreement reflects both the size of the discrepancy between the FCAS and satellite extinctions and the magnitude of the errors supplied by the satellite instrument teams. The discrepancies between the FCAS and SAGE III were on the order of the SAGE III errors for most wavelengths. The discrepancies between the FCAS and POAM III were small compared to the errors reported by POAM III. The discrepancies between the FCAS and SAGE II were often larger than the SAGE II errors but within the combined FCAS and SAGE II errors. The median magnitudes of discrepancies in extinction between the satellite instruments and the FCAS in situ data were in the range from 10% to 30% for most wavelengths. The median signed discrepancies showed that the FCAS extinction values tended to be larger than the SAGE II values and smaller than the SAGE III values.

2) The agreement was worst at the wavelengths shorter than 0.4 μm. The behavior the satellite extinctions at these wavelengths was inconsistent with that predicted from the aerosol size distributions which are physically reasonable.

3) There is significant disagreement between the FCAS aerosol surface and the SAGE II aerosol surface. The disagreement is well outside of the error bars. Compared to SAGE II, the average of the POAM III aerosol surface concentrations was closer to the average of the FCAS aerosol surface area concentration. However, there is still considerable scatter in the POAM III aerosol surface and volume data. There are only 7 comparisons for POAM, but fewer than half of them resulted in acceptable characterizations of the aerosol. Preliminary work not reported on in detail here suggests that large errors in surface are associated with large fractions of the surface appearing on the small particles. That result would not surprise given the difficulties in retrieving aerosol extinction at the shortest wavelengths.

4) The POAM III and SAGE III comparisons are all made at altitudes below 12 km. The discrepancies between POAM III and the FCAS and SAGE III and the FCAS are much smaller than the discrepancies between the FCAS and SAGE II observed at altitudes below 12 km.

5) A high altitude component of the validation exercise is quite important. The profiles assembled for SAGE II are quite informative concerning the performance of the aerosol retrievals in various portions of the atmosphere. The discrepancy between SAGE II and the FCAS is much less above the tropopause. This observation provides a firm basis for comparison of the data acquired near and below the tropopause.

39. Radiometric and Frequency Calibration for EOS-Aura TES Infrared Spectra – Helen M. Worden, Reinhard Beer, Kevin W. Bowman, Brendan Fisher, Mingzhao Luo, Gregory Osterman, David Rider, Edwin Sarkissian, and Denis Tremblay

TES is an infrared Fourier transform spectrometer on board the EOS-Aura spacecraft. The first on-orbit interferograms were acquired August 20, 2004. We present the methods for producing calibrated radiance spectra and show initial results for atmospheric nadir and limb spectra. We also show comparisons of TES nadir spectra to Aqua-AIRS spectra, where the AIRS data are taken on the same orbit path about 15 minutes before TES data are taken.

40. Change in Ozone Trends at Southern High Latitudes – Eun-Su Yang, D. M. Cunnold, M. J. Newchurch, and Ross J. Salawitch

Long-term ozone variations at 60-70˚S in spring have been investigated using both ground-based and satellite measurements. Strong positive correlation is shown between year-to-year variations of ozone and temperature in the ozone hole in Septembers and Octobers. Based on this relationship, the effect of year-to-year vortex dynamical variations have been filtered out. This process results in an ozone time series that shows increasing springtime ozone losses from year to year over the Antarctic until the mid-1990s. Since then the ozone losses have leveled off. The analysis confirms that this change is not due to saturation effects, is consistent across all instruments, and it is statistically significant at the 95% confidence level. The incorporation of SAGE III measurements into such long-term series of measurements is addressed.

41. TES Ozone Retrievals, Error Covariances, and Vertical Resolution – John Worden

Initial ozone retrievals from the Tropospheric Emission Spectrometer are shown for the first TES global survey. Estimated error covariances and vertical resolutions are reported for these regions.